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COOPERATION AND INDIVIDUALISM IN SCIENTIFIC INVESTIGATION

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THE dominant note in the papers and discussions of the biologists at the Baltimore meeting of the American Association for the Advancement of Science and the affiliated societies,[1] December 23–28, 1918, was the plea for greater cooperation among scientists. There were not wanting, however, those who maintained the need of individualism also, and its importance in scientific work. As a result one well-known botanist apparently expressed the feelings of some others when he said that after listening to the various papers he was left in a state of perplexity in regard to these matters. If such perplexity is at all general, it would seem desirable to try to discover its source and come to some better understanding as to the relation of cooperation and individualism in research.

In this case as in many others in which friends and colleagues fail to agree, the trouble appears to be largely due to a difference in interpretation of terms rather than in any real difference of opinion. Confusion of ideas and conclusions come frequently from lack of agreement as to the meaning of terms.

In discussing this subject, some seem to have taken for granted ideas which have not even been stated. As an academic proposition, most of us will agree that the chief aim of scientific investigation should be to advance knowledge and improve the condition of mankind. In attempting to attain the high ideals which are being proclaimed to-day by the leaders in all fields of human endeavor, we must not forget that if the majority of the individuals in any nation or group do not possess these ideals and take a deep personal interest in their attainment, no great progress will be made.

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[1] The following are a few of the papers referred to: Livingston, B. E., "Some Responsibilities of Botanical Sciences," *Science*, N.S., 49, 199–207, February 28, 1919. Coulter, J. M., "The Botanical Opportunity," *Science*, N.S., 49, 363–367, April 18, 1919. Ransom, B. H., Osborn, H., "Methods of Securing Better Cooperation Between Government and Laboratory Zoologists in the Solution of Problems of General or National Importance," *Science*, N.S., 50, 27–30, July 11, 1919. Whetzel, H. H., "Cooperation among Plant Pathologists," *Cornell Countrym.*, 16, 13, 36, 38, 40, February, 1919; "Democratic Coordination of Scientific Efforts," *Science*, N.S., 50, 51–55, July 18, 1919. Lyman, G. R., "The Unification of American Botany," *Science*, N.S., 49, 339–345, April 11, 1919. Harper, R. A., "Stimulation of Botanical Research After the War" (unpublished).

COOPERATION

All are familiar with the ordinary dictionary definition of "cooperation." It is working together for one end or purpose. Cooperation has accomplished much in many fields of human activity. It has been asserted that cooperation won the great war and it undoubtedly was a very important factor. This accomplishment alone would naturally cause the word to appeal to us after having passed through the titanic conflict which has exterminated millions of human beings and is the direct result of the antithesis of cooperation, viz., competition of the basest and most malevolent type.

In cases where the destruction of individuals, families and nations is threatened, many gladly cooperate and work together for the preservation of life and property who would not be willing to forget their petty differences and prejudices and unite their efforts for less striking though equally important purposes in times of peace.

It must be recognized that it is only by organized cooperative effort that many of the great scientific problems now presenting themselves for solution can be successfully attacked. No single human mind can encompass all the knowledge necessary to solve many of the complex problems, which involve a profound knowledge of various branches of science.

Cooperation has been demonstrated to be of great importance in solving many of the problems presented in the present conflicts and activities of the human race. As scientists, we should determine if possible just how this plan can be applied most effectively to the solution of our particular problems. Cooperation in its broadest sense covers of course all interchanges of courtesies and assistance between investigators. If one is investigating an organism or group of organisms and a colleague supplies cultures or material of certain species, this is a simple form of cooperation. On the other hand, it may involve the intimate association of a group of specialists working together for years on some complex problem.

The advancement of science and the solution of its problems depend upon the availability of many materials, instruments and other facilities. Our laboratories, our apparatus, our libraries, our means of publication and illustration, either directly or indirectly are the result of cooperative agencies and activities. The phase of cooperation, however, with which we are most directly concerned at present is that which has been undertaken in connection with scientific work carried on by individuals, offices, bureaus and institutions, in which investigators or institutions pool their interests, funds and men in attacking some broad problem. In such cases, if the investigators are responsible for carrying out the scientific work involved, they must come to some general understanding in regard to the division of labor, resources and other matters involved. In order to carry out such a project, the participants must be actuated by proper motives and not by selfish aims. Most of us will admit as a general proposition that selfishness is the chief source of our troubles in scientific work as well as in other human relations, but we are somewhat sensitive and hesitate to admit it so readily when the application becomes too personal. Few of us, I fear, however, will be prepared to plead entirely innocent.

It should go without saying that there can be no real or successful cooperation between persons who undertake the work in the spirit of horse traders, the chief aim being to see which can get the best of the bargain. Neither can successful cooperation be inaugurated and carried on by command or direction of those in authority. The cooperation must be voluntary and the problem attacked must be adapted to cooperative effort. Cooperation can not be applied to advantage in all cases and under all conditions. Its applicability and effectiveness must depend upon the particular problem and the individuals involved.

To attain the best results the participants should also be optimists, not pessimists. An excellent criterion has recently been proposed to classify individuals in this respect by determining their attitude toward oysters. The optimist is said to be always looking for pearls and the pessimist for ptomaine poison.

An obstacle to cooperation among organizations and institutions is the more or less artificial divisions of the field of investigation which have been made chiefly for administrative purpose, but which must sometimes be disregarded by mutual consent in order to attack and solve a problem most effectively and quickly. Unfortunately there are sometimes directors of scientific work who lack sufficient understanding of the problems involved to approve and encourage cooperation among the investigators who are naturally fitted for and willing to do such work.

Cooperation in scientific work is not comparable to joining hands in mere manual labor. In such cases we may simply lighten each others burdens or accomplish the task quicker. In cooperating on a scientific problem each worker should contribute something which he is better fitted to perform than any other of the cooperators. The contribution of each differs chiefly in kind or quality instead of quantity.

It may be said that sufficient difficulties have already been mentioned to demonstrate the impracticability, if not the impossibility, of any general or effective cooperation in research. We refuse, however, to take such a pessimistic view of the situation and can not believe that the present generation of scientists is so hopeless. Our faith in the possibility and practicability of cooperation among scientists is not founded entirely upon academic grounds, but upon actual demonstration by experiment.

Many will be able to recall one or more examples of successful cooperation in attacking some scientific problem. To cite a specific case in phytopathology we may refer to the recent investigation of chestnut blight. Mutually agreeable cooperative arrangements were made between different offices in the Department of Agriculture and various experiment station workers to attack different phases of the problem. This cooperation was so broad that it included entomologists as well as physiologists, pathologists, taxonomists and chemists. By this arrangement all the varied aspects of the problem were studied, and much greater and more rapid progress was made in the solution of the whole problem than could have been made by any other plan. Unfortunately, lack of funds prevented carrying certain phases of the work to completion, but this was no fault of the plans or the investigators involved.

The problems in plant pathology being those with which we are most intimately acquainted we may be pardoned for citing an example of work which is typical of many pathological investigations in which cooperation is essential for success. Recently investigations of the cause and prevention of the decay and spoilage of fruit and vegetables in transportation and marketing have been undertaken. It was soon found that much more knowledge of the normal and pathological physiology of such plant products must be obtained. This required the service of specially trained, expert physiologists and biochemists. As many microorganisms were also involved in the decay, expert mycologists and pathologists were needed to solve the problems connected with their life history, relationships and physiological characteristics. Certain practical phases of the work also required the assistance of pomologists, refrigeration and market experts. It would appear self-evident that no one person could do the work necessary to carry such an investigation to a successful conclusion. It might be said that the problem could be separated into its various parts and assigned to physiologists, biochemists, pathologists, mycologists and various other experts to work out by themselves. Experience has proved that the problem can not be economically or effectively solved in this manner. The various phases form such an intricate, complex problem that it is only by specially trained investigators working in closest cooperation and mutual understanding that the problem can be solved.

The best known general cooperative effort in plant pathology is that undertaken by the War Board of the American Phytopathological Society. In order to bring to bear as effectively and quickly as possible the available facts needed in preventing losses from plant diseases, especially of the staple food products and also to acquire as quickly as possible more necessary information, the board undertook to facilitate and encourage cooperative work among the men best fitted to attack the various problems involved. The essential features of the plan were voluntary offers of cooperation by the individuals and mutual agreement among the cooperators in the selection of a leader for each project. The results of the cooperative efforts inaugurated by the war board for the war emergency were so important and successful that the great majority of American pathologists have signified their desire to see the work continued as a permanent project. As a result, a new board called the advisory board of the society has been appointed and is specifically delegated to promote cooperative work among pathologists.

The familiar quotation from Shakespeare "There is a tide in the affairs of men which taken at the flood leads on to fortune" is especially applicable just now. If we interpret the signs correctly such a tide is now flowing and we should as scientists take all possible advantage of it. If according to the inscrutable plans by which the universe is guided, such a frightful slaughter as we have just witnessed was necessary in order to provide for the future advancement and welfare of humanity, it is not only an opportunity but a grave and imperative duty which presents itself at this time. The world as never before is looking to scientists for leadership, help and encouragement. The intellectual and spiritual battles which must be fought and won in the immediate future far surpass in importance the physical conflicts we have just passed through.

If the recently reorganized National Research Council lives up to the high aims set forth by the President in his executive order it will offer the greatest opportunity for organized cooperative effort in research that has ever occurred. It is to be hoped that it will be so supplied with the necessary funds and the support of all scientific investigators that it may fully demonstrate the advantages of cooperative effort in science.

Its measure of success must depend in great part upon the personel of the council. The importance of this is clearly and forcibly expressed by Dr. Hale, the former chairman of the council, in his invitation to the scientific societies to nominate representatives for membership in the council. He says:

> The future success of the National Research Council and the part to be taken by the United States in the International Research Council, of which it is the American member, will be chiefly determined by the representatives of the societies comprised in its membership. Recognized ability in research, wide understanding of its possibilities, keen interest in its promotion, and willingness to give time and thought to the work of the Research Council are the prime qualifications sought; whereas mere seniority in the profession, and scientific or technical activity without special interest in research, are evidently of themselves insufficient.

Every scientist and every scientific organization should take an active interest in the Research Council, giving it all the assistance possible, in order that it may carry out the great purposes for which it has been established. We should not only regard it as a great opportunity, but as a great obligation. The world is looking to us for cooperation and leadership in science as well as in political matters. Let us not disappoint it. We now have the necessary organization for cooperating with the various scientific organizations throughout the world. If this agency is properly utilized there should be a great acceleration in the advancement of science in the near future.

INDIVIDUALISM

It may appear to some that very little room is left in this scheme for individualism. The impression seems to prevail that there is a real conflict between the terms "cooperation" and "individualism." This we believe is due again to failure to properly define and understand the true significance and application of the terms. But a few years since, we were hearing much about the conflict between science and religion. To-day it is generally accepted that between true science and true religion there can be no conflict; both must have their basis in truth. The same may be said of cooperation and individualism. Between cooperation and individualism, in their proper application, there can be no conflict, for their aim is the discovery and application of truth. The chief problem is to determine the most effective manner in which each can be utilized in advancing science.

The fullest exercise of individual initiative, ability and expression in research, has in the past been most seriously interfered with by lack of encouragement and of funds and facilities, and by administrative restrictions.

It has been asserted that scientists, especially those endowed with extraordinary ability in research, should be free to follow unrestrained and unhampered wherever the spirit leads them. The best work in science as well as in art and literature must be primarily spontaneous and voluntary; but some guidance, some assistance and much encouragement may be given, the kind and amount depending upon the individuals involved and the problems under investigation.

Darwins and Edisons are rare. The future advancement of science must depend chiefly on the combined efforts of the mass of faithful seekers of truth whose names may never appear near the top of the scroll of honor of the world's greatest scientists.

Every effort should be made and every facility offered the individual investigator to utilize and develop in the most effective way all the ability for research which he may possess, but however brilliant the individual may be or however narrow or special his problem, cooperation in some form may be found advantageous. Individualism and originality should find full expression in the recognition of specific problems and their analysis and in the planning and carrying on of experiments and observations which give promise of leading to their solution or adding something of importance to the sum of human knowledge.

In general, special problems which do not require too great a diversity of knowledge of the various branches of science are best adapted to solution by individual effort, while broad and general problems can be more efficiently attacked by cooperation among individuals, each having free scope for the full exercise of his special training and ability in attacking some special phase of the general problem, the co-workers comparing results and coordinating their work by frequent conferences.

The applicability of cooperation and individualism in any particular case must be determined by the nature of the problem involved and the special ability and training of the investigators.

As we have tried to point out, there are plenty of problems and opportunities for the fullest exercise of the ability of the individual investigator as well as for cooperative efforts. The fundamental requirements for the success of either form of activity or combination of the two will depend largely upon the ideals and aims of the individual investigators involved. If their primary motives are love of research, the advancement of science and the improvement of mankind, there is not likely to arise any great difficulty in determining the best plan of work. If, however, baser motives dominate, the greatest success can not be attained.